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APPLYING ELECTRICAL SURVEY TO DETECT THE THICKNESS OF THE EPIKARST

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Abstract

Defining the thickness of the epikarst plays an important role in hydrogeological surveys. The epikarst has an impact on the regime, balance, and groundwater quality. Electrical surveys, especially the technique of vertical electrical sounding (VES), can help to define the thickness of the epikarst. The paper presents the results obtained using the VES technique on the survey area located in the eastern part of Suva planina Mt. for detecting the thickness of the epikarst. The results obtained for the survey area bring new information about the thickness of the epikarst in the survey area.

***Keywords**: the epikarst, vertical electrical sounding, Suva planina Mt.*

1. INTRODUCTION

Epikarst is the highest part of the rock mass that is exposed to karstification, and, in a karst area, this layer plays an important role in protecting the karst formation. The main characteristics of epikarst are the accumulation of underground water and the creation of conditions for the formation of concentrated flows in the bedrock [1]. The thickness of the epikarst zone varies in the range from 10 cm to 30 m and is generally estimated from a few meters to 10-15 meters [2].

In this paper we present the results of electrical surveys that we applied to detect the thickness of the epikarst. Electrical surveys were done by the technique of vertical electrical sounding (VES).

As a practical example, we used the VES measurements which were done in the eastern part of Suva planina Mt., on location Rakoš and Bukovica.

2. METODOLOGY

Electrical surveys were done using the technique of vertical electrical sounding (VES). The VSE technique is often used in karst investigation [3]. The VSE technique is applied to detect the change of electrical resistivity with depth using the Schlumberger array.

The Schlumberger array consists of four electrodes, which are sited in a line around a common midpoint. Two electrodes A and B are current electrodes – outer electrodes, and two electrodes M and N are potential electrodes – inner electrodes. To get the maximum depth penetration in the VES procedure, the current electrodes are moved away, and the distance between the potential electrodes does not change, hence increasing the depth penetration. The electrical sounding diagrams were obtained by application of this technique, and the electrical resistivity is given as a function of the half-distance of the current electrodes (AB/2) [4].

During the investigation in the survey area, the distance between the current electrodes (AB/2) ranges from 30 m to 110 m.

3. STUDY AREA

Suva planina Mt. is in SE part of Serbia, approximately 230 km from Belgrade (Fig. 1). In Suva planina Mt. the karst aquifer system is formed in the limestones of Middle and Upper Jurassic and Lover Cretaceous age [1].

The study area is situated in the eastern part of Suva planina Mt. in location Rakoš and Bukovica (Fig. 1).

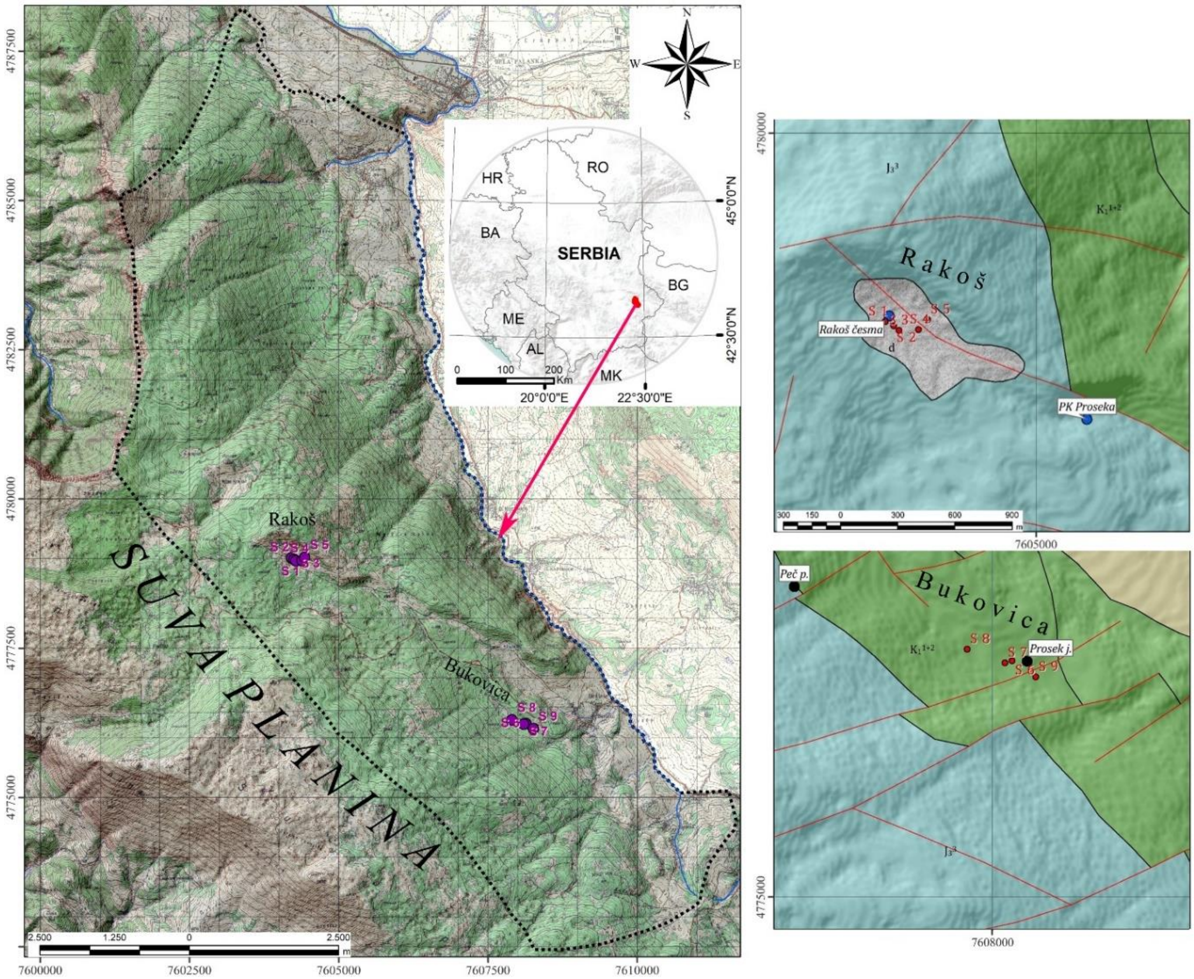

Figure 1. Map of survey area (easter part of Suva planina Mt.) with position of VES points - location Rakoš S1-S5 and location Bukovica S6-S9

4. RESULTS AND DISCUSSION

In the survey area, the thickness of the epikarst was defined by the VES technique. Measurements applying the VSE technique were done on locations Rakoš and Bukovica. The distance between the current electrodes (AB/2) was 30 m in the Rakoš area, while the distance between the current electrodes in the Bukovica area was 30 m and 110 m.

At the Rakoš location, the VES measurements were done along profiles S1-S5 (Fig. 1). The results in points S1, S2 and S3 show that the measurements were done in the fault zone (Fig. 2). This zone is without a diluvial overlayer with high values of specific electrical resistivity from the surface to a depth of over 2 m. Measuring points S1 and S2 are placed over the fault zone on a relatively raised block with a diluvial layer and debris material in it. Measuring points S4 and S5 are located on the raised flank of the fault, and S5 is positioned the farthest from the fault zone. The data from S5 shows that diluvium and clay are found in this part, which are washed closer to the fault and eroded onto the flank that descends (Fig. 2). There are zones of lower and higher resistivity that are the results of VES measurements at the Rakoš. The resistivity in the shallowest part of the terrain is high and indicates that this part of the terrain contains limestone rubble in a dried clay matrix. The change by depth of high and low resistivity (S1-S4) is related to the change of dry, larger limestone blocks and degraded limestone belts with water or clay as filling. At point S5 (Fig. 2), the VES measurements show that such heterogeneity of the limestone is not visible, but under the clay layer lies weakly cracked limestone, to a depth of almost 20 m.

The results of VES on location Rakoš (Fig. 2) indicate the layer consisting of decomposed and altered limestone rock material (breccia and debris) and soil, which in this case represents epikarst. The thickness of the epikarst at the Rakoš ranges from 3 to 15 meters.

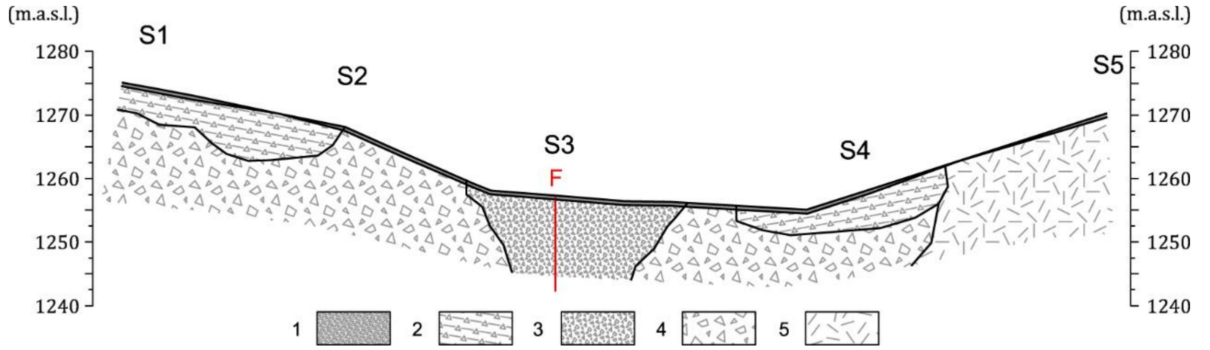

Figure 2. The interpretation of the VES measurements (S1-S5) at location Rakoš: 1- soil, 2 - colluvium with clay infill (epikarst), 3 – resedimented breccias (epikarst), 4 – limestone (epikarst), 5 – highly karstified limestone, F – fault (according [1])

On location Bukovica, the measurements of VSE were completed along profiles S6-S9 (Fig. 1). In points S6, S7, S8 and S9 the results of measurements show that it is done in the fault zone (Fig. 3). Along the S6-S9 profile, the results indicate that resistivity increases with depth and that there is a dry system of cracks, pits and caverns below the surface.

The results of VES on location Bukovica indicate the layer consisting of decomposed and altered limestone rock material (breccia) and soil, which represents epikarst in this case (Fig. 3). The thickness of the epikarst at Bukovica ranges from 1.5 to 9 meters. The epikarst lies over a well karstified limestone in which there is a system of caverns, dry cracks, and larger channels in this area.

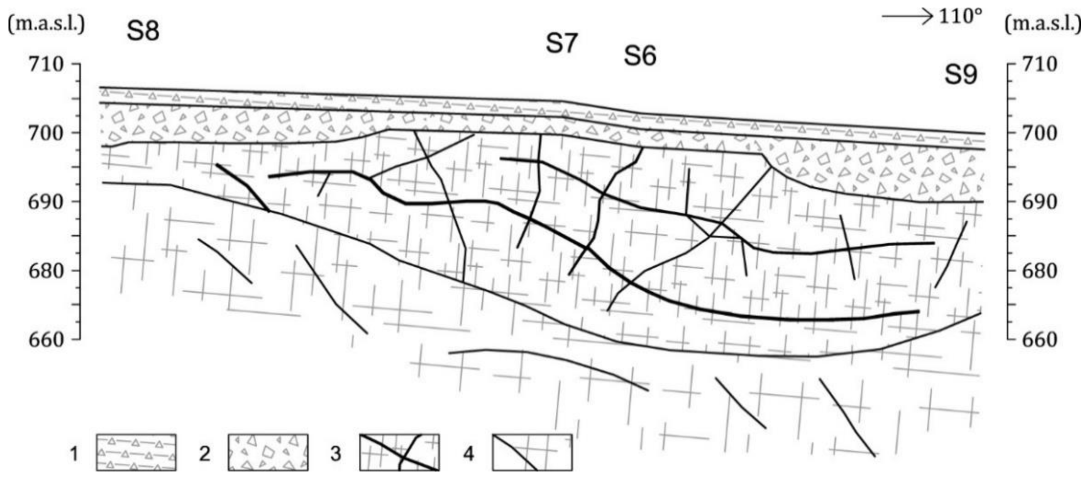

Figure 3. The interpretation of the VES measurements (S6-S9) at location Bukovica: 1- soil and colluvium with clay infill (epikarst), 2 – limestone breccias (epikarst), 3 – well karstified limestone, 4 – weak karstified limestone (according [1])

5. CONCLUSION

The results obtained using the VES technique on the survey area located in the eastern part of Suva planina Mt., on location Rakoš and Bukovica, helped to define the thickness of the epikarst in the survey area. At the Rakoš, the thickness of the epikarst ranges from 3 to 15 meters. The thickness of the epikarst at Bukovica ranges from 1.5 to 9 meters. The results of VES measurements bring new information about the thickness and distribution of fractured and karstified zones in the survey area. The thickness of the epikarst decreases with declining quality (cleanliness) of carbonate rocks, enhancement of slope, and distance from fault zones. The new information about the thickness of the epikarst in survey areas can help in future hydrogeological surveys.

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REFERENCES

[1] B. Petrović, Funkcionisanje i uticaj epikarsta na režim, bilans i kvalitet podzemnih voda istočnog dela karstnog sistema Suve planine, Doktorska disertacija, Univerzitete u Beogradu Rudarsko– geološki fakultet, Beograd, 2020, p.291.

[2] A.B. Klimchouk, Towards defining, delimiting and classifying epikarst: Its origin, processes and variants of geomorphic evolution, speleogenesis and evolution of karst aquifers. – Speleogenesis and Evolution of Karst Aquifers, 2/1, (2004) 1-13.

[3] T.D. Bechtel, F.P. Bosch, M. Gurk, Geophysical methods, in: Methods in Karst Hydrogeology, (eds. Goldscheider N. & Drew D.), IAH, vol 26. Taylor & Francis/Balkema, London, (2010) 171-200.

[4] J.M. Reynolds, An Introduction to Applied and Environmental Geophysics, 2nd Edition. – Wiley-Blackwell, (2011) p.712